

## NESTING, EGG-LAYING AND HATCHING OF THE SNAKE-NECKED TORTOISE AT CANBERRA, A.C.T.

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(Plates IV-V)

### SUMMARY

Eggs of the Snake-necked Tortoise, *Chelodina longicollis* (Shaw), were laid in nest cavities dug into sloping ground during or soon after rain. The nest cavities were sealed with a plug of compacted damp soil which baked hard in the sun. Eggs hatched after 118 to 143 days. Incubation time appeared to depend on temperature as eggs laid in January and February took longer to hatch than those laid in November and December. After hatching the young tortoises are confined to the nest cavity until rain softens the plug and they can emerge.

### I. INTRODUCTION

Harrington (1933) and Goode (1965) have given detailed descriptions of the nesting behaviour of some captive Australian tortoises including the Snake-necked Tortoise, *Chelodina longicollis* (Shaw), but they give no information on what happens in the wild.

This paper reports the nesting behaviour of *Chelodina longicollis* (Shaw), near Canberra, in the Australian Capital Territory, where it was studied from 1958 to 1960 and from 1962 to 1967.

### II. STUDY AREA

The study area (Plate IV) included a pond with an area of about 750 sq. yds. at Gungahlin near Canberra. The northern quarter of the area surrounding the pond was a slope and the remainder of the surroundings was flat ground. The pasture around the pond comprised a mixture of Spear grass, *Stipa falcata*, and *S. aristiglumis*, Rush, *Juncus* sp., Blue Devil, *Eryngium rostratum*, Dock, *Rumex brownii*, Plantain, *Plantago lanceolata*, and Spear Thistle, *Cirsium vulgare*.

The slope leading down to the pond included an area of about 900 sq. yds. growing mainly Yellow Buttons, *Helichrysum apiculatum*, interspersed with mosses. Also present were Spear Thistle, *C. vulgare*, Blue Devil, *E. rostratum*, Spear grass, *S. falcata*, *Danthonia* spp. and a *Poa* species. The vegetation on the *Helichrysum* patch was less dense than elsewhere around the pond. No trees or shrubs were present on the slope or nearby.

The soil profile in the area dominated by *Helichrysum apiculatum* was as follows: 0-4 in.—brownish-grey to brown medium clay containing a considerable amount of gravel with pieces up to  $\frac{1}{2}$  in.; 4-6 in.—heavy clay with large pieces of decomposing shale; below this was a heavy clay with much larger pieces of shale impenetrable to a soil auger.

In the area surrounding the *Helichrysum* patch the soil was less heavy in texture and the profile was as follows: 0-4 in.—brownish-grey loamy-clay with a small amount of gravel with pieces up to  $\frac{1}{16}$  in.; 4-7 in.—brownish-grey medium clay; below this was a heavy clay with large pieces of decomposing shale.

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### III. METHODS

Nests of *C. longicollis* were found by regularly and systematically searching the study area and by following trails left by animals from the water. Nests were marked with a serial number on a wooden stake hammered into the ground approximately 6 in. to the east side of each nest. To enable the contents of the nest to be checked from time to time, the plug with which the female had sealed the nest cavity was cut round with a knife and it was then lifted out gently. After each inspection the plug was replaced and pressed down. Some plant debris was used to camouflage the nest after each check.

Eggs and young tortoises were taken out of the cavities with a pair of long blunt-nosed forceps. Ovulation was observed by dissection and measurement of the ovary. Measurements of eggs and the carapace of the embryo and of young were made with calipers.

### IV. RESULTS

#### (a) Copulation

Copulation was observed only twice—on September 22, 1958, and on October 4, 1965—and did not appear to differ from the description by Worrell (1962). Ovulation followed one or two months later; there was no evidence that it was initiated by copulation.

Barney (1922) and Hildebrand (1929) recorded that spermatozoa would survive for four years in impregnated Diamond-back Terrapins, *Malaclemys centrata*. Ewing (1943) found that Box Turtles, *Terrapene caroline*, continued to produce eggs into the fourth year after mating. In *C. longicollis* a female kept in solitary captivity for nine months still produced fertile eggs. Another animal, collected during November, laid fertile eggs after 12½ months.

#### (b) Nesting and Nesting Place

A description by Harrington (1933) of nest digging by *C. longicollis*, stated that this took place on moonlit nights. In 21 observations of nest building around Canberra only two of these were on moonlit nights. Daily checks in the morning on the study area indicated that *C. longicollis* would dig a nest at night *during or after rain*. Only one animal was found digging a nest during the afternoon, and this was on an overcast and dull day. Three recordings of eggs being laid during the day were obtained from eight animals kept in captivity.

Harrington (1933) indicates that the nesting place is 3 ft. from the edge of water. Of the 20 nests observed in the Canberra study area the minimum distance from the water's edge was 6 ft., while the maximum was 310 ft. Most nests were approximately 30 ft. from the water.

One nest was found 2 ft. above the highest waterline; all the other 19 were between 7 and 9 ft. above it.

Nests were never found outside the *Helichrysum* patch. One reason for this may simply have been that in this area the vegetation was lower and less dense. The soil in this patch was probably harder to dig in, as indicated by the profile. As this area had better drainage there was less chance of the eggs being flooded.

Harrington (1933) recorded the time for preparing the cavity as approximately half an hour. His observations were in an enclosure with sandy soil. At Canberra digging times for four nest cavities were 45, 65, 70, and 80 minutes. An indication that longer times could occur was that an animal in captivity took 185 minutes to complete the cavity after a previous attempt to dig in a very shallow layer of soil above a rock. This animal rested several times for periods up to seven minutes and was seemingly greatly handicapped by sticky clay.

These observations agree with Harrington's statement that the time needed to dig a cavity depends on the physical characteristics of the soil.

Most authors mention the use of cloacal fluid to moisten soil for digging. The present observations were made during rain and the excretion of cloacal fluid has not been noticed.

(c) The *Nest Cavity* (Fig. 1)

The entrance to the pit in which the eggs are laid has an average diameter of  $2\frac{1}{4}$  in. for a distance of  $1\frac{1}{4}$  to 2 in., then the burrow widens to a round or elongated chamber. Of 12 nests nine were elongated.

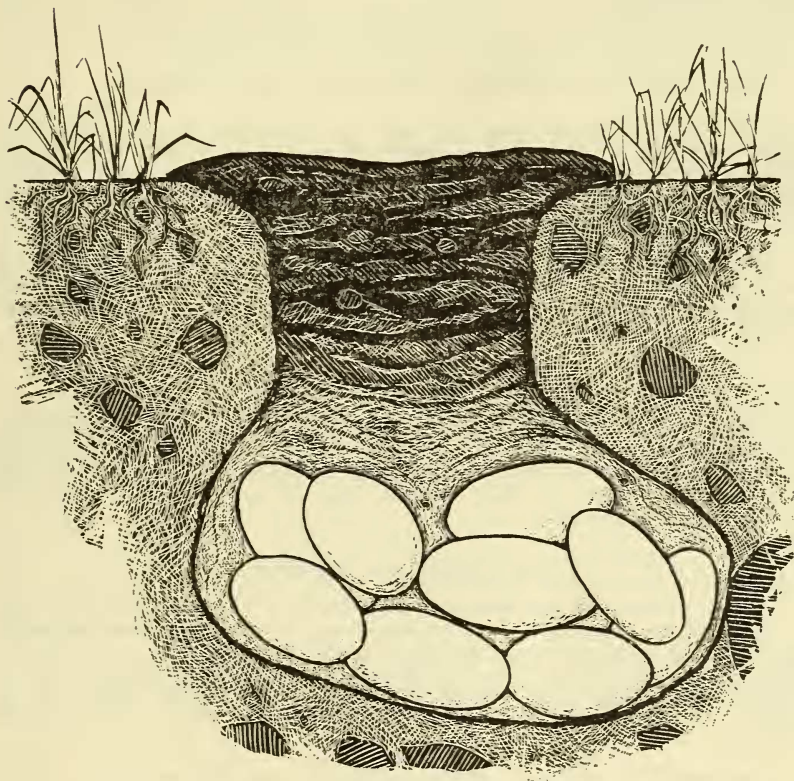


Fig. 1.—Nest cavity.

TABLE 1  
RANGE OF MEASUREMENTS OF 12 NESTS OF *CHELODINA*  
*LONGICOLLIS*

	Maximum (mm)	Minimum (mm)	Mean (mm)
Depth of nest from surface ....	127	82	113
Length of chamber ....	127	89	115
Height of chamber ....	57	32	51
Width of chamber ....	63	51	57

The range of measurements of 12 nests is given in Table 1.

Eggs are laid after the nest has been dug. The actual process of egg-laying of *C. longicollis* is the same as described by Goode (1965) for *Emydura macquarii*. If no soil is available eggs may be laid in water (pond at Canberra Community Hospital, March 6, 1967), or on a concrete floor (Narrabundah, A.C.T., June 27, 1967).

During 1963, 1964, and 1966, a number of nest holes were dug and were left open. No explanation can be given for this behaviour, which has also been observed by the author in the Green Turtle, *Chelonia mydas*, in 1948 in east Java, Indonesia.

(d) *Date of Egg-laying*

Waite (1929) cites November and December as egg-laying time for South Australia, while Goode (1965) stated that in Victoria the period was midsummer. In Canberra the earliest date recorded was November 8, while the last eggs were laid on January 3. With animals kept in captivity later dates were recorded, up to June 27.

(e) *Clutch- and Egg-Sizes*

Only one clutch of eggs is laid in the season. In 15 nests, the largest clutch was 24 eggs, the smallest 13, and the mode was 19 eggs. The time needed for animals to lay clutches was observed on four occasions as 9, 13, 18, and 21 minutes for 19, 18, 24, and 18 eggs respectively. There were only four females, of the same size, whose clutch-sizes were known. There was no evidence of any relationship between the size of the animal and of its egg clutch.

The ranges of length and width of 142 eggs are given in Table 2. Goode (1967) says that egg size depends on the size of the female and may vary by as much as 10 mm in length.

TABLE 2  
RANGE OF MEASUREMENTS OF 142 EGGS OF  
*CHELODINA LONGICOLLIS*

	Maximum (mm)	Minimum (mm)	Mean (mm)
Length ....	33.8	21.0	30.3
Width ....	21.3	12.5	19.6

(f) *Closing the Nest*

After the eggs are laid the tortoise scoops the soil back into the nest entrance. The surplus soil is scooped on top of the already closed entrance, the tortoise then lifts its body as high as possible by stretching the four legs, and drops it heavily on top of the loose soil. This movement is repeated until all the soil is tamped down on top of the entrance. The packed soil in the entrance varied between 45 mm and 63 mm thick. When the entrance had been closed the animals returned to the water.

The time involved in closing the nest entrance depends on the moisture content of the soil. When the soil was damp three animals took an average of 30 min. to close the nest holes. In a muddy soil each of two animals took about 125 min., and they had difficulty in separating the muddy earth from feet and plastron, and several long rests were taken during the labour of closing the entrance. Goode (1965) has given similar descriptions of tamping of the soil by *Emydura macquarii*. Harrington (1933) apparently overlooked this aspect in *C. longicollis*.

The nest entrance could be easily found in the first few days after digging, except in plant-free areas where no traces could be observed after two days. The evidence of digging was eventually obliterated by rain and after the soil had been sunbaked for weeks the top layer of the plug dried out so much that it was rock-hard. Nearby plants which had been flattened during the digging, soon recovered. No plants grew on top of the entrance for the rest of the year in which the digging occurred.

(g) *Egg Losses*

Harrington (1933) stated that rats ate the eggs of *C. longicollis*; no evidence of this was found in the present study. The tortoise uses the hindfoot to arrange the eggs in the burrow and during this procedure the sharp claws may puncture the eggs. Punctured eggs were found in 12 nests out of 20 and egg losses from this cause varied from 8% to 25% per clutch. Punctured eggs have been found infested with fly maggots.

Arthropods, including wood-slaters (Isopoda), spiders (Arachnida), centipedes (Chilopoda), and insects (Insecta) were commonly found in nest cavities. Insects included spring-tails (Collembola), ground-beetles (Coleoptera, fam. Carabidae), rove-beetles (fam. Staphilinidae), and histerid beetles (fam. Histeridae). No indications were found that any of these arthropods cause damage to the eggs.

In five clutches all eggs were infertile; the other 23 clutches had between 5% and 50% infertile eggs. The number of infertile eggs seems to increase in clutches that are laid in the second half of the breeding season, as is shown in Table 3.

TABLE 3  
INFERTILE EGGS IN CLUTCHES DURING THE 1966/67 SEASON

Laying Dates	Number of Eggs in Clutch	Number of Infertile Eggs
28.xi. 1966	18	1
28.xi. 1966	21	0
28.xi. 1966	17	1
13.xii. 1966	20	6
13.xii. 1966	17	9
29.xii. 1966	19	15
3. i. 1967	18	16

Two nests which were found during the 1966-67 season and which were not properly closed by the animal contained desiccated eggs only. Dented eggs were common, probably because there are usually two layers of eggs in the nest cavity. Eggs with dents hatched successfully.

(h) *Development*

Development of the embryo was not obvious during the first 15 days after egg-laying.

Three clutches, all of the same age, were sampled at intervals by taking one egg from each clutch; the size of the embryo at various ages was determined by measuring the carapace. Measurements are given in Table 4.

TABLE 4  
MEASUREMENTS OF CARAPACE OF EMBRYOS

Age of Eggs <sup>1</sup> (days)	Embryos <sup>2</sup> Measured	Nest A		Nest B		Nest C	
		Length (mm)	Width (mm)	Length (mm)	Width (mm)	Length (mm)	Width (mm)
32	3	No carapace developed					
40	3	First sign of development of carapace					
62	3	9.8	7.8	10.5	8.0	10.3	8.0
80	3	15.9	13.9	16.0	14.5	16.0	14.2
122 <sup>3</sup>	3	22.0	19.5	21.5	19.2	22.7	19.8

<sup>1</sup> Laying date 2.xii.1966.

<sup>2</sup> One egg from each nest.

<sup>3</sup> The hatching age for some eggs in the same nest.

The incubation period for these eggs was 122 days. Shorter and longer periods have been recorded. During the 1966/67 season, eggs laid in November hatched after 118 to 125 days, while eggs laid in December took 131 to 143 days to develop. In the study area only one nest was recorded with eggs laid as late as January 3. Hatching of these eggs occurred after 148 to 150 days.

The incubation period seems to depend on temperature. Eggs laid between early November and the second half of December receive more heat than at any other time of the year. After February the soil temperature drops (Fig. 2), but the tortoises are still able to hatch as late as early June.

A longer incubation period was observed in eggs laid by an animal in Ainslie, A.C.T., on January 13, 1960.

Measurements were made of the carapace in the embryos from this nest. Only one embryo could be measured on each date. Data are given in Table 5.

TABLE 5  
MEASUREMENTS OF CARAPACE OF EMBRYOS FROM EGGS IN  
ONE NEST (AINSLIE, A.C.T.)

Age of Eggs <sup>1</sup> (day)	Number of Embryos	Length (mm)	Width (mm)
60 ....	1	5.0	2.5
84 ....	1	9.0	7.2
132 ....	1	11.0	9.1
191 ....	1	12.1	10.5

<sup>1</sup> Laying date 13.i.1960.

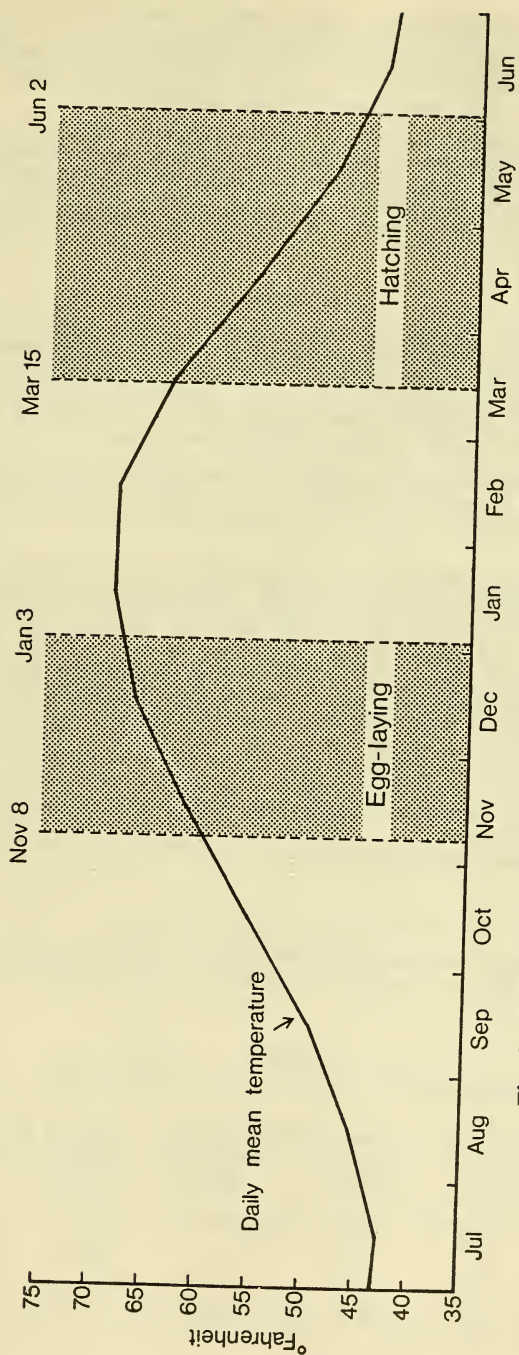


Fig. 2.—Egg laying and hatching periods of *Chelodina longicollis* at Canberra, A.C.T. in relation to monthly average daily mean temperature. (Temperature data from Commonwealth Bureau of Meteorology 1956—"Climatic Averages Australia.")

Insufficient eggs were available for development to be followed to hatching.

Data in Tables 4 and 5 show the slower developments in a late clutch. The average carapace length in clutches laid in early December was 10.2 mm after 62 days of incubation, while in a clutch laid in January the carapace length was still only 11.0 mm., after 132 days of incubation.

Gadow (1900) pointed out that in *Emys orbicularis* the hatching of the eggs is deferred until the next spring, the embryo's development being arrested during the winter. In *C. longicollis* the development of the embryos slowed down during the winter, but due to the unavailability of eggs no evidence could be obtained that the hatching would have been delayed until the next spring.

#### (i) Hatching

When the embryo is completely developed it cuts its egg shell with its caruncle. This "hatching tooth" is 0.4 mm long, has its point curved upwards, and is situated approximately 1 mm under the nostrils on the premaxilla. Tortoises which feed soon after hatching and are active, lose their caruncle after three or four weeks. Some remained inactive after hatching and retained the caruncle for more than three months, losing it during the winter.

The newly-hatched tortoise is unable to retract its head under the carapace.

The yolk sac is still connected at the plastron centre between the hyoplastron and hypoplastron plates; the remains drop from the animal after two to three days.

Evidence was obtained that young are unable to leave the nest until it rains. Regular inspection of nests indicated that young were found in the cavity some days and weeks after hatching, but they left the cavity after the first rain. In an observation in January 1965, eggs of the same nest were divided up into three batches and were buried in three nest-holes, identical in size and depth to the original nest. One batch was given an artificial rain shower every two weeks; the second was subjected to natural rainfall; and the third batch did not receive any water but was able to obtain normal sunlight. An intact nest of the same age was checked regularly for normal development. The eggs in the nest which received artificial showers decayed; those in the nest which received normal rainfall hatched and the young were able to leave the nest 10 days after hatching. The third batch was kept dry for 30 days after hatching, then the entrance was soaked with water, and 20 minutes later the young left the burrow for the nearest water (Plate V).

#### (j) Size of the Young Tortoises

The carapaces of newly hatched tortoises were measured and the animals were returned to the nest cavity. Measurements were obtained again after 10 and 30 days.

TABLE 6  
CARAPACE SIZE OF YOUNG TORTOISES

Age of Young (days)	Place	Number of Animals	Length of Carapace Maximum (mm)	Carapace Minimum (mm)	Width of Carapace Maximum (mm)	Carapace Minimum (mm)
0-1	in nest cavity	14	23.0	21.5	20.0	19.0
10	in nest cavity	33	29.0	27.0	25.5	22.5
30	in nest cavity	7	29.5	27.0	25.7	22.7